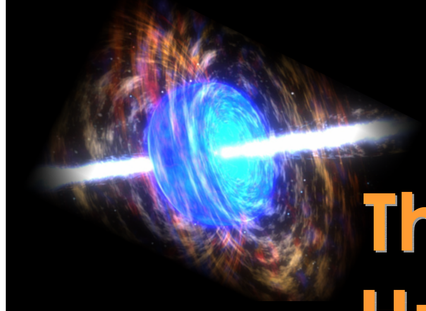
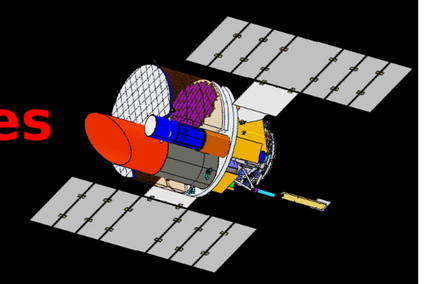
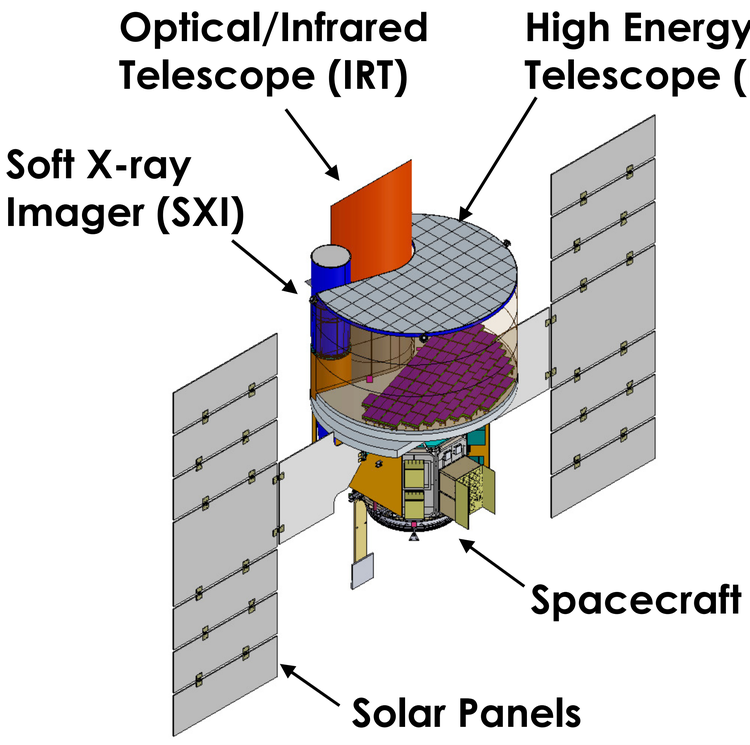


EXIST: Surveying the birth and evolution of Black Holes



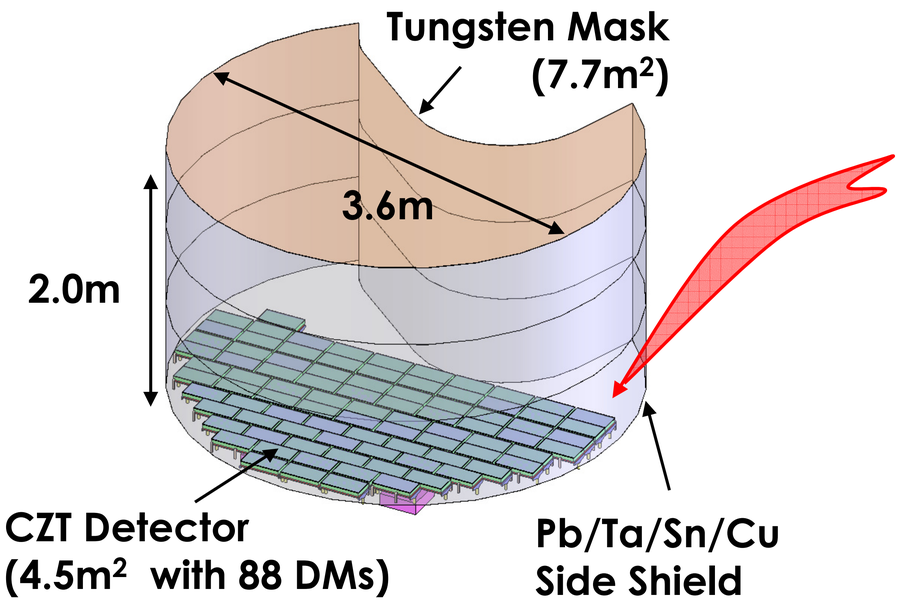
The High Energy Telescope on EXIST: Hunting High Redshift GRBs and Other Exotic Transients

Jaesub Hong, Jonathan Grindlay, Branden Allen (CfA), Gerald Skinner (GSFC), Mark Finger (MSFC), Garrett Jernigan (Berkeley) and the EXIST Team



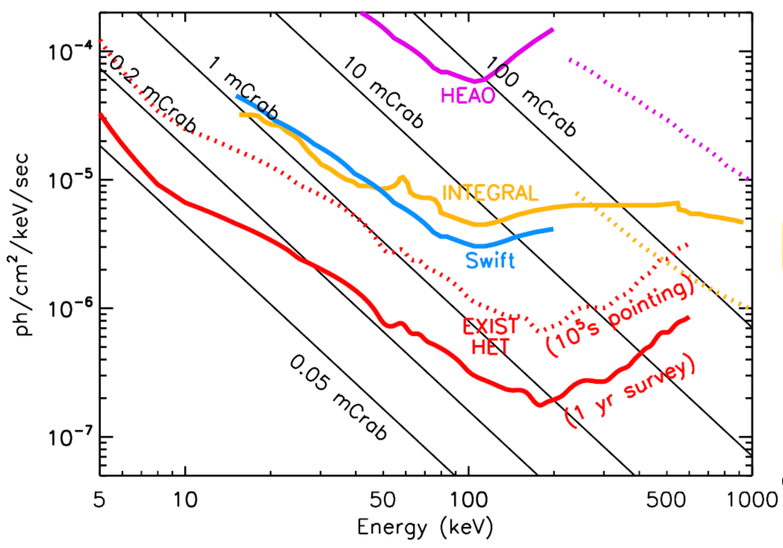
EXIST Mission Concept

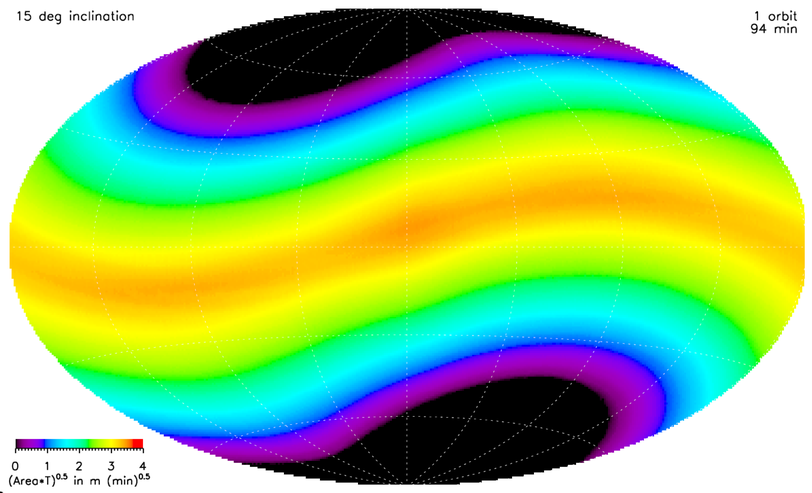
The Energetic X-ray Imaging Survey Telescope (EXIST) is newly redesigned to locate high redshift Gamma-Ray Bursts (GRBs) and other exotic transients quickly (<10 sec) and accurately (<20") in order to allow rapid (<1–2 min) followup onboard optical/IR imaging and spectroscopy (see 217.03 for overview). For this, EXIST now consists of the High Energy Telescope (HET), the Soft X-ray Imager (SXI) and the Optical/infrared Telescope (IRT, see 435.06 & 07) .



High Energy Telescope (HET)

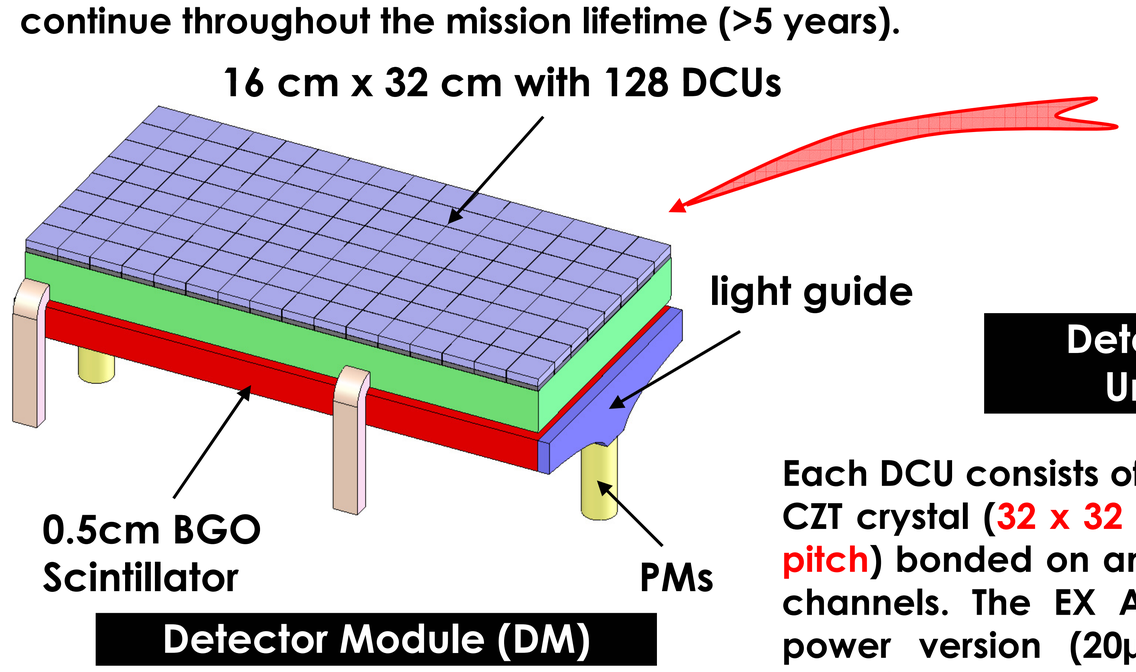
The HET employs coded-aperture imaging with a 4.5m² CZT detector and hybrid tungsten mask (see 453.08). The wide energy band coverage (5–600 keV) is optimal for capturing GRBs and other exotic transients and highly obscured AGNs. The CZT detector plane consists of 88 identical Detector Modules (DMs) and it is surrounded by graded Z passive shields that set the field of view. The full sky image will be continuously updated onboard in a series of time intervals from 1 to ~1000 sec in order to efficiently detect GRBs and flaring sources.





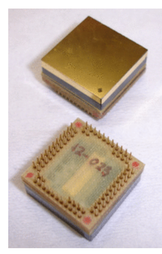
1-year Survey Sensitivity (5σ) and One Orbit Sky Coverage (95min)

The 1-year survey sensitivity of the HET is expected to be ~0.1–0.2 mCrab, depending on the energy range. The continuous scan with the wide field of view (~90° x 70° at 10% coding fraction) increases the chance of capturing rare elusive events such as soft Gamma-ray repeaters and tidal disruption events of stars by dormant supermassive black holes. Sweeping nearly the entire sky every two orbits (3 hours) will also establish a finely-sampled long-term history of the X-ray variability of many X-ray sources, opening up new possibilities of variability studies (see 453.02). Continuous scanning is also desirable for optimal imaging performance by averaging out unknown systematic noises. After the initial 2 years of the full sky survey in scanning mode, EXIST will be primarily in the pointing mode for followup studies (X-ray/IR spectra, source id and redshifts) of selected samples of the ~20,000 AGNs in the survey (see 435.03 & 05). GRB detections and afterglow followups will continue throughout the mission lifetime (>5 years).



Detector Module (DM)

Each DM consists of 128 Detector Crystal Units (DCUs) backed up by BGO rear anti-coincidence shields. The low threshold of CZT detectors (~4–5 keV) allows a significant overlap of energy band with the SXI (0.2–10 keV). BGO scintillators work as the high energy spectrometer for GRBs, extending the energy band coverage up to a few MeV.



Detector Crystal Units (DCUs)

Each DCU consists of 2 x 2 cm² x 0.5 cm CZT crystal (32 x 32 pixels; 0.6mm pixel pitch) bonded on an EX ASIC with 1024 channels. The EX ASIC will be a low power version (20μW/pix) of the DB ASIC for NuSTAR, which shows <2 keV resolution (FWHM) at 60 keV. Fine pixels allow 20" localization of 5σ sources and provide good polarization sensitivity (see 453.01). The picture shows DCUs for *ProtoEXIST1* using RadNet ASIC (64 channels, 2.5mm pixel). *ProtoEXIST1* is the first in a series of balloon-borne prototype experiments to develop the CZT technology for the HET on EXIST (see 474.08).

The Key Mission Parameters for EXIST/HET

- Nearly full sky coverage every two orbits (~3hr) for capturing GRBs/transients and exploring new variability
- 5–600 keV wide energy coverage with CZT detectors (<2–3 keV res., FWHM) for unveiling distant, obscured sources
- <20" localization (5σ), <100 sec slew for rapid onboard Optical/IR imaging and spectroscopy of GRB afterglows
- Detect ~300 – 700 GRBs/year, including ~10 – 60 GRBs/year with z>6 (Salvaterra et al, 2008, MNRAS, 385, 189)
- Detect ~20,000 AGNs from 2 yr scanning survey (~0.1 mCrab, 5σ) & additional ~10,000 in 3 yr pointed phase: full survey sensitivity ~0.05 mCrab or ~5 x10^{-13} cgs